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Molecular phylogeny of placodioid lichen-forming fungi reveal a new genus, *Sedelnikovaea*

S.Y. KONDRATYUK^{1*}, M.-H. JEONG², I.A. GALANINA³,
L.S. YAKOVCHENKO^{3,4}, A.P. YATSYNA⁵, & J.-S. HUR²

¹ M.H. Kholodny Institute of Botany of National Academy of Sciences of Ukraine, Kiev, Ukraine

² Korean Lichen Research Institute, Suncheon National University, Suncheon, Korea

³ Institute of Biology and Soil Science FEB RAS,

Stoletiya Vladivostoka Avenue 159, 690022 Vladivostok, Russia

⁴ Botanical Garden-Institute FEB RAS, Makovskogo st. 142, 690024 Vladivostok, Russia

⁵ V.F. Kuprevich Institute of Experimental Botany of National Academy of Sciences of Belarus,
Akademicheskaya str. 27, 220072 Minsk, Belarus

CORRESPONDENCE TO *: ksya_net@ukr.net

ABSTRACT — A molecular phylogeny based on ITS1/ITS2 and mtSSU DNA sequences is presented for lichen-forming fungi in *Protoparmeliopsis* and its distant relative *Sedelnikovaea* gen. nov. The positions of the two genera in the phylogenetic tree of the families *Lecanoraceae* and *Lecideaceae* are discussed. The new combination *Sedelnikovaea baicalensis* ($\equiv$ *Lecanora baicalensis*) is proposed. The unique *Sedelnikovaea*-type ascus is described and illustrated. *Sedelnikovaea baicalensis* and *Zwackhiomyces zareii* are for the first time recorded from China.

KEY WORDS — *Biatora*, *Rhizoplaca*, *Protoparmelia*, *Candelariella*, *Steinia*, *Pycnora*

Introduction

The lichen-forming fungal genus *Protoparmeliopsis* comprises a total of ca. 44 species (Santesson 2004; Kondratyuk 2010; Kondratyuk et al. 2012, 2013 b). After Arup & Grube (2000) provided the first molecular data for *Protoparmeliopsis*, five new species and 42 new combinations have been proposed in the genus (Kondratyuk 2010; Kondratyuk et al. 2012, 2013b; Santesson 2004).

Protoparmeliopsis is not currently classified in the *Lecanoraceae* (Lumbsch & Huhndorf 2007, 2010) due, in part, to lack of molecular data and unresolved relationships within *Lecanora* sensu lato. Sequences from only three species — *P. achariana* (A.L. Sm.) Moberg & R. Sant., *P. macrocyclos* (H. Magn.) Moberg

& R. Sant., and *P. muralis* (Schreb.) M. Choisy — are available in GenBank. Several species recently described in *Protoparmeliopsis* (or recently combined in the genus based on morphology; Kondratyuk 2010, Kondratyuk et al. 2012, 2013 b) are here included in a molecular analysis.

Material & methods

Specimens were prepared using standard microscopical techniques: specimens were hand-sectioned under Nikon SMZ645 dissecting microscope, examined under Nikon E200 and Olympus BX51 microscope, and photographed using the Olympus DP-Soft photo program.

TABLE 1. Specimens included in the phylogenetic analysis

TAXON NAME	COUNTRY / VOUCHER	ITS1/ITS2	12S SSU mt DNA
<i>Adelolecia pilati</i>	Norway?, Ekman 3373 (BG)		AY567713
	Norway?, Ekman 3373 (BG)		AY300874
<i>Aspicilia caesiocinerea</i>	AFTOL-ID 653		DQ986892
<i>Aspicilia cinerea</i>	AFTOL-ID 647		DQ986890
	Sweden	EU057899	
<i>Boreoplaca ultrafrigida</i>	China		HQ026247
	AFTOL-ID 1702		DQ986813
	Russia		AY853312
<i>Circinaria calcarea</i>	Sweden	EU057898	
	Sweden		AY853310
	Austria?/ Wilfling (GZU)	AF332108	
	AFTOL-ID 1358		DQ986876
<i>Circinaria desertorum</i>	USA	EU057905	
	Russia		HM060689
<i>Circinaria hispida</i>	Iran	HQ389197	
	SK A12, Ukraine, Kharkiv oblast, Dvorychansky district, 'Korobchyno' zakaznik, 19.vi.2013 M. Kryvokhyzhaya (KW-L)		KP059052
	SK A15, Ukraine, Kharkiv oblast, Dvorychansky district, 'Korobchyno' zakaznik, 19.vi.2013 M. Kryvokhyzhaya 2 (KW-L)		KP059053
	Turkey		HM060722
<i>Farnoldia jurana</i>	Austria		GU074511
<i>Hypocenomyce scalaris</i>	AFTOL-ID 1025	HQ650632	
	Sweden		AY853325
	United Kingdom	FR799187	
	Sweden		AY853326
	AFTOL-ID 687		DQ912274
<i>Japewia tornoenis</i>	Canada	EF495163	
	?/ Printzen s. n.	HQ650656	
	Canada		HQ660559
<i>Lecanora achroa</i>	Thailand	JN943715	
	Australia	JN943719	
<i>Lecanora albescens</i>	Poland?/ Kubiak Jan. 2009 (KRAM)	JQ993727	
<i>Lecanora allophana</i>	Norway?, Ekman 3434 (BG)		AY567710
<i>Lecanora argentata</i>	Thailand	JQ782704	

TAXON NAME	COUNTRY / VOUCHER	ITS1/ITS2	12S SSU mt DNA
<i>Lecanora bicincta</i>	Austria?/ U. Trinkaus 102 (GZU)	AY541264	
<i>Lecanora caesiorubella</i>	Australia		JQ782672
<i>Lecanora campestris</i>	Sweden?/ U225	AF159930	
	Sweden?/ U514		DQ787362
<i>Lecanora carpineae</i>	Sweden?/ U507		DQ787364
	Austria?/ J. Pruegger 61232 (GZU)	AY541247	
<i>Lecanora crenulata</i>	Poland?/ Sliwa 4087 (KRAM)	JQ993725	
<i>Lecanora contractula</i>	AFTOL-ID 877	HQ650604	
	AFTOL-ID 877		DQ986898
<i>Lecanora dispersa</i>	Hungary?/Lökös Jan. 2009 (KRAM)	JQ993733	
<i>Lecanora dispersoareolata</i>	Austria?/ M124	AF070016	
<i>Lecanora farinacea</i>	Austria?/ U. Trinkaus 115 (GZU)	AY541261	
	Australia	JN943725	JQ782672
	Australia		JQ782670
<i>Lecanora flavopallida</i>	Australia	JN943723	JQ782674
	Australia		JQ782673
<i>Lecanora fuscescens</i>	Hauck s. n.	HQ650652	
<i>Lecanora gangaleoides</i>	USA		JQ782676
<i>Lecanora glabrata</i>	Sweden?/ U444		DQ787360
<i>Lecanora hagenii</i>	Hungary?/ Lökös Jan. 2009 (KRAM)	JQ993735	
<i>Lecanora hybocarpa</i>	?/ Lumbsch s.n. (F)		EF105417
<i>Lecanora intricata</i>	Austria ?	AY398703	
<i>Lecanora intumescens</i>	Norway?, Ekman 3162		AY567715
<i>Lecanora kenjana</i>	Kenya	JQ900618	
<i>Lecanora novomexicana</i>	USA	HM577255	
<i>Lecanora paramerae</i>	?/ Lumbsch s.n. (F)		EF105418
<i>Lecanora perpruinosa</i>	Sweden?/ U176	AF070025	
<i>Lecanora polytropa</i>	Antarctica, Hur ANT050752	DQ534470	
<i>Lecanora reuterii</i>	Poland?, Sliwa 4113 (KRAM)	JQ993741	
<i>Lecanora rupicola</i>	Spain	DQ451670	
<i>Lecanora semipallida</i>	Poland?/ Sliwa 4102 (KRAM)	JQ993755	
<i>Lecanora subcarpineae</i>	Slovenia	DQ451657	
<i>Lecanora sulphurea</i>	Sweden?/ U508		DQ787356
<i>Lecanora swartzii</i> subsp. <i>caulescens</i>	Austria?/ M. Grube s.n. (GZU)	AY541272	
<i>Lecanora swartzii</i>	Austria	DQ451655	
<i>Lecanora tropica</i>	Kenya	JN943718	
	Thailand	JN943720	JQ782699
<i>Lecanora valesiaca</i>	Sweden?/ U512		DQ787350
<i>Lecidea fuscoatra</i>	AFTOL-ID 589	HQ650707	
	Sweden, Arup L02723 (Hb. Arup)		HQ660567
	Turkey	HQ605929	
	Turkey	HQ605927	
	Sweden?/ Wedin 6860 (UPS)		AY756401
	AFTOL-ID 589		DQ912275
<i>Lobothallia alphoplaca</i>	USA	JX306737	
	USA	JX306739	
<i>Lobothallia melanaspis</i>	Norway	JF825524	
	Sweden		HM060688
<i>Lobothallia radiosa</i>	Sweden	JF703124	
	Switzerland		DQ780274
<i>Lobothallia recedens</i>	Sweden		HM060724

TAXON NAME	COUNTRY / VOUCHER	ITS1/ITS2	12S SSU mt DNA
<i>Megaspora verrucosa</i>	Austria? /1996, Trinkaus (GZU)	AF332121	
	Austria?/ Hafellner 48544 & Ivanova (GZU)	AF332122	
	Sweden		HM060687
	Iran		JQ797483
<i>Protoparmelia atriseda</i>	USA	KF562190	
<i>Protoparmelia badia</i>	Austria	KF562191	
	Sweden?/ U167	AF070023	
	Australia		AF351179
	Austria	EU075540	
	?/ Lumbsch s.n. (F)		EF105420
<i>Protoparmelia cupreobadia</i>	USA	KF562192	
<i>Protoparmelia isidiata</i>	USA	JF821184	
<i>Protoparmelia montagnei</i>	BCC-Lich 13178	AF101277	
<i>Protoparmelia picea</i>	Norway	KF562194	
<i>Protoparmelia psarophana</i>	BCC-Lich 13180	AF101279	
<i>Protoparmeliopsis achariana</i>	Sweden?/ U155	AF070019	
	Sweden?/ U525		DG787342
<i>Protoparmeliopsis garovaglii</i>	Austria?/ M107	AF189718	
<i>Protoparmeliopsis macrocyclos</i>	Sweden?/ U273	AF159933	
<i>Protoparmeliopsis muralis</i>	SK 765; Romania, 2011 J.-S. Hur (RO11-130). (Kol.RJ)	KP059048	KP059054
	Sweden?/ U509		DQ787340
	Poland	HM209239	
	Schmull s. n.	HQ650653	
<i>Protoparmeliopsis zarei</i>	SK 480, Iran, Esfahan Province, Mooteh Wildlife refuge, 50°39'56"E 33°25'34"N, 2510 m alt., 21.VII.2010 B. Zarei-Darki (1111) (KW-L)	KP059049	KP059055
	SK 481, Iran, Esfahan Province, Mooteh Wildlife refuge, 50°39'56"E 33°25'34"N, 2510 m alt., 21.VII.2010 B. Zarei-Darki (1108) (KW-L)		KP059056
<i>Pycnora sorophora</i>	Sweden, Hermansson 7903a (UPS)	FJ959357	AY853338
<i>Pycnora xanthococca</i>	Sweden, Hermansson 11849 (UPS)	AY853388	AY853339
<i>Pyrrhospora quernea</i>	Norway?, Ekman 3019 (BG)	AF517930	AY567712
	Norway?, Ekman 3019 (BG)		AY300908
<i>Pyrrhospora sanguinolenta</i>	Australia, Elix 28835 (F)	EU075548	
<i>Ramboldia brunneocarpa</i>	Australia	EU075542	
<i>Ramboldia stuartii</i>	Australia	EU075549	
<i>Rhizoplaca bullata</i>	Spain		AY464070
<i>Rhizoplaca chryssoleuca</i>	USA	HM577253	
	Sweden?/ U503		DQ787354
	China, Wei, 3, 8/5/2002	AY509799	
<i>Rhizoplaca haydenii</i>	USA	HM577302	
<i>Rhizoplaca idahoensis</i>	USA	HM577297	
<i>Rhizoplaca melanophthalma</i>	Switzerland	JX948232	
	Sweden?/ U519		DQ787352
<i>Rhizoplaca occulta</i>	USA	HM577307	
<i>Rhizoplaca parilis</i>	Chile	JX948227	
<i>Rhizoplaca peltata</i>	China, Wei, 22-c, 2001	AY530887	
	China, Guo, 3557, 8/1/2003	AY509802	
<i>Rhizoplaca polymorpha</i>	USA	JX948194	

TAXON NAME	COUNTRY / VOUCHER	ITS1/ITS2	12S SSU mt DNA
<i>Rhizoplaca porteri</i>	USA	HM577381	
<i>Rhizoplaca shushanii</i>	USA	HM577294	
<i>Rhizoplaca subdiscrepans</i>	China, Wang, 13-2, 8/4/2002	AY509789	
<i>Scolicosporum chlorococcum</i>	United Kingdom	FR799323	
	Norway?, Ekman 3390 (BG)		AY567768
<i>Scolicosporum umbrinum</i>	Austria?, A. Wilfling 2873 (GZU)	AY541277	
	Norway?, Ekman 3005 (BG)		AY567719
	Norway?, Ekman 3005 (BG)		AY300911
<i>Sedelnikovaea baicalensis</i>	SK A13, China, Inner Mongolia, 42°01'011"N, 116°17'738"E, 1434 m alt., 8.viii.2009 J.-S. Hur & X.Y. Wang CH090322 KoLRI 010936	KP059050	KP059057
	SK 776, China, Inner Mongolia, 42°01'011"N, 116°17'738"E, 1434 m alt., 8.viii.2009 J.-S. Hur & X.Y. Wang CH090322 KoLRI 010936	KP059051	KP059058
	SK A18, China, Inner Mongolia, 43°36'272"N, 116°43'242"E, 1260 m alt., 10.viii.2009 J.-S. Hur & X.Y. Wang CH090352 (KoLRI 010966)		KP059059
<i>Steinia geophana</i>	Germany		JN222812
<i>Xanthomendoza mendozae</i>	Chile	EU681351	
	Chile	EU681349	EU680937
	Argentina	EU681350	EU680938
<i>Xanthomendoza kashiwadani</i>	Chile		EU680936
<i>Xylopsora friesii</i>	United Kingdom	FR799184	
	Sweden		AY853324

Results

We submitted data on *P. muralis* and *P. zarei* S.Y. Kondr. into GenBank for the first time, as ITS rDNA and 12SSU mtDNA sequence analyses confirm both species within *Protoparmeliopsis*. Phylogenetic analysis also shows that another Asian species, *P. baicalensis* (Zahlbr.) S.Y. Kondr., is outside the genus and very distant from *Protoparmeliopsis*. Our anatomical examination of material of '*Protoparmeliopsis*' *baicalensis* revealed that this taxon is characterized by a unique ascus-type (PL. 3), which we henceforth refer to as the *Sedelnikovaea*-type. Consequently we propose a new genus, *Sedelnikovaea*, for this species, *S. baicalensis*.

Sedelnikovaea baicalensis and *Zwackhiomyces zarei* S.Y. Kondr. (KoLRI 10971, on *Rhizoplaca chrysoleuca*, see below under specimens examined) are for the first time recorded from China.

Taxonomy & phylogeny

Protoparmeliopsis M. Choisy, Bull. Soc. Bot. France 76: 523 (1929).

TYPE SPECIES — *Lichen muralis* Schreb. [= *Protoparmeliopsis muralis*]

Thallus commonly distinctly placodioid. Apothecia lecanorine. Asci of *Lecanora*-type. Ascospores hyaline, simple.

Protoparmeliopsis comprises approximately 44 species. For a detailed description of the genus and its history, see Kondratyuk (2010).

MOLECULAR PHYLOGENY — As a monophyletic group *Protoparmeliopsis* has high bootstrap support based on results from nuclear (ITS1/ITS2) and mitochondrial (12S SSU) DNA sequence analyses that included four *Protoparmeliopsis* species (FIGS 1, 2).

The status of such species as *P. macrocyclos* and *P. garovaglii* (Körb.) S.Y. Kondr. still requires further study.

Protoparmeliopsis is not generally accepted (Lumbsch & Huhndorf 2007, 2010), probably because the *Lecanora* s. lat. clade itself has a rather high bootstrap support (see PL. 2). However, relationships among lineages within *Lecanora* s. lat. remain largely unresolved, and improved sampling is required to circumscribe genera within this group adequately.

A parallel case is the *Dufourea* s. lat. clade in *Xanthorioideae*, *Teloschistaceae* (Kondratyuk et al. 2014b, and Fedorenko et al. 2009, 2012; Kondratyuk et al. 2013a as *Xanthodactylon* s. lat. clade). However within this clade *Dufourea* Ach. s. str., *Jackelixia* S.Y. Kondr. et al., *Ovealmbornia* S.Y. Kondr. et al., *Langeottia* S.Y. Kondr. et al., and *Xanthokarroa* S.Y. Kondr. et al. have strong individual bootstrap support values, with each monophyletic branch also characterized by a unique set of morphological, anatomical, and biochemical characters.

Similarly ITS1/ITS2 nrDNA (PL. 1) and 12S SSU mtDNA (PL. 2) analyses strongly support *Protoparmeliopsis* within the *Rhizoplaca/Protoparmeliopsis* clade. The genus is probably as polyphyletic as *Rhizoplaca* Zopf (Arup & Grube 2000, Arup et al. 2007, Leavitt et al. 2011, 2013), *Protoparmelia* M. Choisy (Lendemer & Lumbsch 2008, Papong et al. 2011, Sing et al. 2013), and *Lecanora* Ach. (Grube & Blaha 2003, Grube et al. 2004, Lumbsch et al. 2012, Sliwa et al. 2012).

***Sedelnikovaea* S.Y. Kondr., M.H. Jeong & Hur, gen. nov.**

MYCOBANK 810705

Differs from *Protoparmeliopsis* in having a unique type of ascus in some respects similar to *Candelariella*- and *Biatora*-type, and by its close molecular similarity to members of the *Lecideaceae*.

TYPE SPECIES — *Lecanora baicalensis* Zahlbr. [= *Sedelnikovaea baicalensis*]

ETYMOLOGY — honouring lichenologist Nellia Vasiljevna Sedelnikova (Novo-sibirsk, Russia) in recognition of her contribution to our knowledge of Asian lichen flora.

Thallus distinctly placodioid, rosette-like, apothecia lecanorine, asci of *Sedelnikovaea*-type, 8-spored; ascospores simple, hyaline.

TAXONOMIC POSITION — This new genus is proposed for the single species *Sedelnikovaea baicalensis*, morphologically similar but only distantly related to species in the putative genus *Protoparmeliopsis*. Molecular data (see

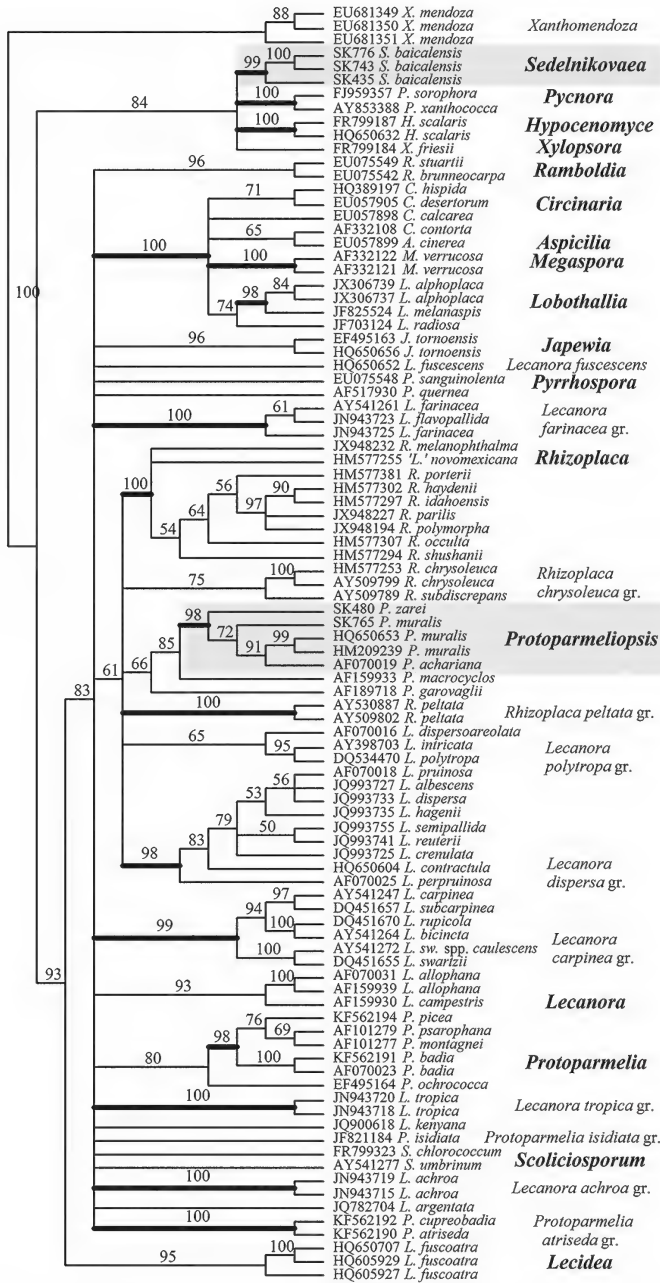


PLATE 1. The phylogenetic tree of *Protopermeliosps* and *Sedelnikovaea* and representatives of *Lecanoraceae* and *Lecideaceae*, based on the ITS1/ITS2 gene of nuclear DNA.

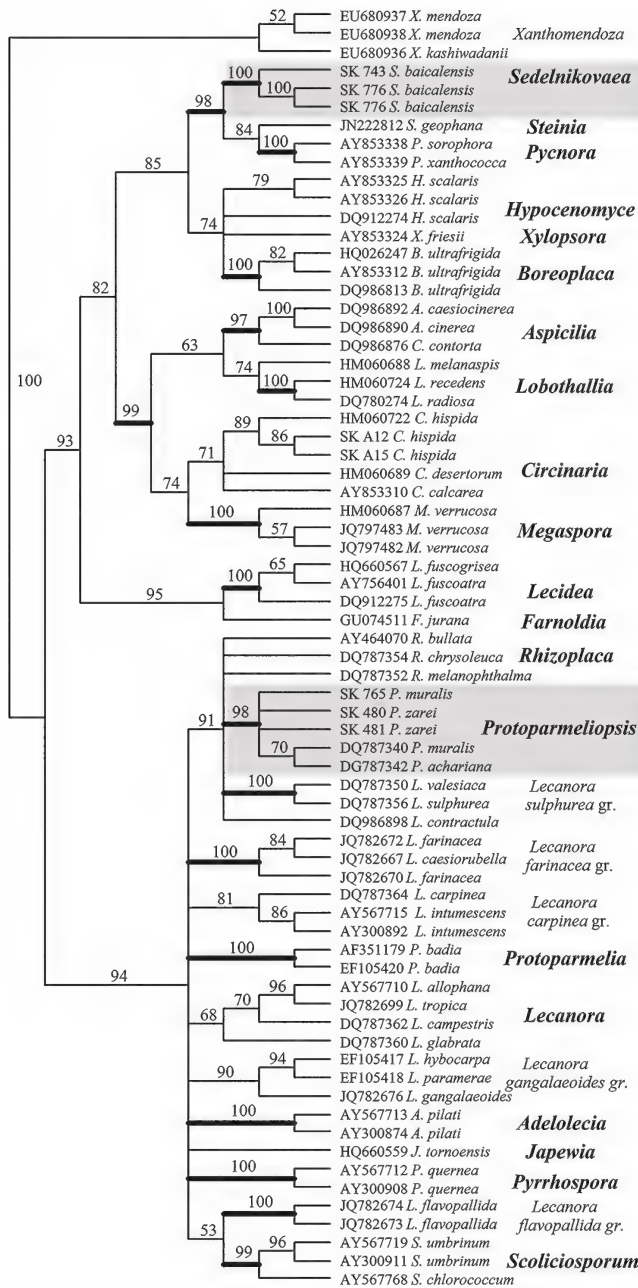


PLATE 2. The phylogenetic tree of *Prototermeliopsis* and *Sedelnikovaea* and representatives of *Lecanoraceae* and *Lecideaceae*, based on the 12S SSU gene of mitochondrial DNA.

below) indicate a close relationship with the *Lecideaceae* or *Megasporaceae*. Morphological and anatomical comparisons show important differences from *Protoparmeliopsis* species, primarily a somewhat grey-brownish (instead of greenish) thallus and possession of a unique *Sedelnikovaea*-type ascus, described below.

***Sedelnikovaea baicalensis* (Zahlbr.) S.Y. Kondr., M.H. Jeong & Hur, comb. nov.**

MYCOBANK 810706

PL. 3–4

- ≡ *Lecanora baicalensis* Zahlbr., Trav. Sous-Sect. Troitzkossawsk.-Khiakta, Sect. Pays d'Amour, Soc. Imp. Russe de Géogr. 12: 85. 1911 ["1909"].
- ≡ *Placolecanora baicalensis* (Zahlbr.) Kopach., Nov. Sist. Niz. Rast. 9: 293. 1972.
- ≡ *Protoparmeliopsis baicalensis* (Zahlbr.) S.Y. Kondr., Ukr. Botan. Zhurn. 96 (6): 876. 2012.

Thallus crustose, rosette-like, up to 1–2.5 cm across, often forming larger aggregations, rather thick, in section to 1 mm thick, densely attached to the substrate, distinctly lobate in peripheral zone and sometimes areolate in the centre, upper surface rough to slightly verruculose, matt to slightly shiny, grayish brown to brownish, yellow-brownish or ochraceous-brown. Lower surface dark brown to blackish-brown. Apothecia up to 1–1.5 mm diam., lecanorine (in section zeorine), mainly rounded, attenuated at the basis, disc shiny at first, subconvex to convex when mature, light-brown to light reddish brown; thalline margin narrow, entire to crenulate, sometimes disappearing in senescence. True exciple up to 30 µm thick in lateral portion and somewhat indistinct in basal portion. Hymenium up to 50–70 µm high, epihymenium 15–20 µm thick, brownish. Subhymenium up to 100 µm thick, underlying an algal layer up to 50–80 µm thick. Paraphyses rather lax. Asci 50–57 × (13–) 15–18(–20) µm. Ascospores ellipsoid, 11–18 × 5–7 µm. Thallus K–, C–, Pd+ slightly reddish.

SPECIMENS EXAMINED – RUSSIA, CHITA REGION (OBLAST), KYRINSKY DISTRICT, 2 km SW of Chita-Khapcheranga junction, 49°45'21.40"N 112°20'08.60"E, 1184 m alt., shale rocks, 28 July 2008 Yakovchenko (VBGI); Sokhondinskiy biosphere reserve, vicinity of 'Buninda' Forest Station, 49°42'20.46"N 111°21'55.36"E, 1294 m alt., experimental plot 31, Steppe S-facing rocky slope with granitoid stones, 24 July 2008 Yakovchenko (VBGI); Sokhondinskiy biosphere reserve, vicinity of 'Agutsa' Forest Station, 49°39'57.16"N 111°25'39.11"E, 1130 m alt., Steppe S-facing rocky slope with *Pinus sylvestris* in the upper part of the slope near the Station, 02 September 2009 Yakovchenko (VBGI); Sokhondinskiy biosphere reserve, vicinity of 'Agutsa' Forest Station, 49°39'55.03"N 111°25'39.42"E, 1115 m alt., S-facing rocky slope with granitic gneissic rocks near the Station, 20 July 2008 L. Yakovchenko (VBGI); "Gornaya Step" Protected Area, division of Sokhondinskiy biosphere reserve, 14 km S of Kira Village, 49°24'N 112°03'E, 970 m. alt., vicinity of 'Gazultiy' Forest Station, 'Sukhaya Padj' locality, Multiterb prairie with fragments of kharganat-type of vegetation on the S-facing rocky slope, 03 August 2005 Yakovchenko (VBGI); ZABAIKALSKY TERRITORY (KRAY), ONONSKIY DISTRICT, road from Verkhniy Sharanay Village to Undino Poselë Village, 3.5 km W of Zarya

Village, 51°08'51.10"N 116°01'35.70"E, 606 m alt., steppe S-facing slope with shrubs and rocks, 01 August 2008 Yakovchenko (VBGI); TSASUCHEYSKIY DISTRICT, road from Nizniy Tcasuchey to Aginskoe, 500 m N of the Bridge on Onon River, vicinity of "Krasny Bator" nature monument, 50°31'45.00"N 115°01'19.10"E, 631 m alt., steppe slope with granitic rocks, 30 July 2008 Yakovchenko (VBGI); AKSHINSKIY DISTRICT, 11 km NE of Mogoytuy Village and 10 km N of the junction to Nizniy Zasuchey, 50°24'35.10"N 113°58'04.40"E, 768 m alt., vegetation of kharganat-type (cereals – *Filifolium* – herb steppe with *Armeniaca sibirica*) and shale rocks on S-facing slope, 28 July 2008 Yakovchenko (VBGI); KRASNOKAMENSKIY DISTRICT, 6.9 km NNE of Tselinniy Village, 50°19'00.60"N 118°08'41.30"E, 710 m alt., Spurs of Klichinskiy Range, steppe top of spur with granitic gneissic rocks, 05 August 2008 Yakovchenko (VBGI). CHINA. NEIMENGGU PROVINCE, DUOLUN COUNTY, Shisanlitan, 42°02.560'N 116°17.014'E, 1324 m alt., on rock, growing together with *Caloplaca subsoluta*, 2009 Hur CH090318 (KoLRI 10932); CH090321 (KoLRI 10935); CH090322 (KoLRI 10936); 42°01.011'N 116°17.738'E, 1434 m alt., on rock growing together with *Protoparmeliopsis muralis*, 2009 Hur CH090332 (KoLRI 10946); XILIN COUNTY, Mountain, 43°36.272'N 116°43.242'E, 1260 m alt., on rock, 2009 Hur CH090347 (KoLRI 10961), CH090352 (KoLRI 10966); growing together with *Candelariella* sp. and *Rhizoplaca chrysouleuca* damaged by *Zwackhiomyces zareii*, CH090357 (KoLRI 10971). UZBEKISTAN. Along Dugave River, 23 August 1950 N. Shafeyev 97 (MSK-L).

MOLECULAR PHYLOGENY — Our ITS rDNA analyses (Pl. 1) show *Sedelnikovaea baicalensis* as closely related to *Steinia* Körb. and *Pycnora* Hafellner (*Lecideaceae* or *Lecanoromycetidae* incertae sedis), while our mt DNA analyses (Pl. 2) place the species with *Boreoplaca* Timdal (*Lecanoraceae*)

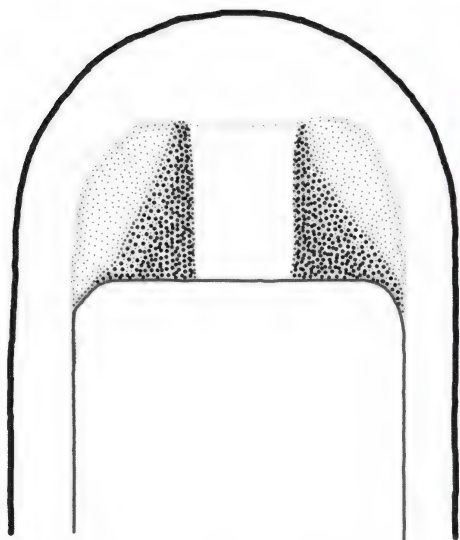


PLATE. 3. Asci of *Sedelnikovaea* type.

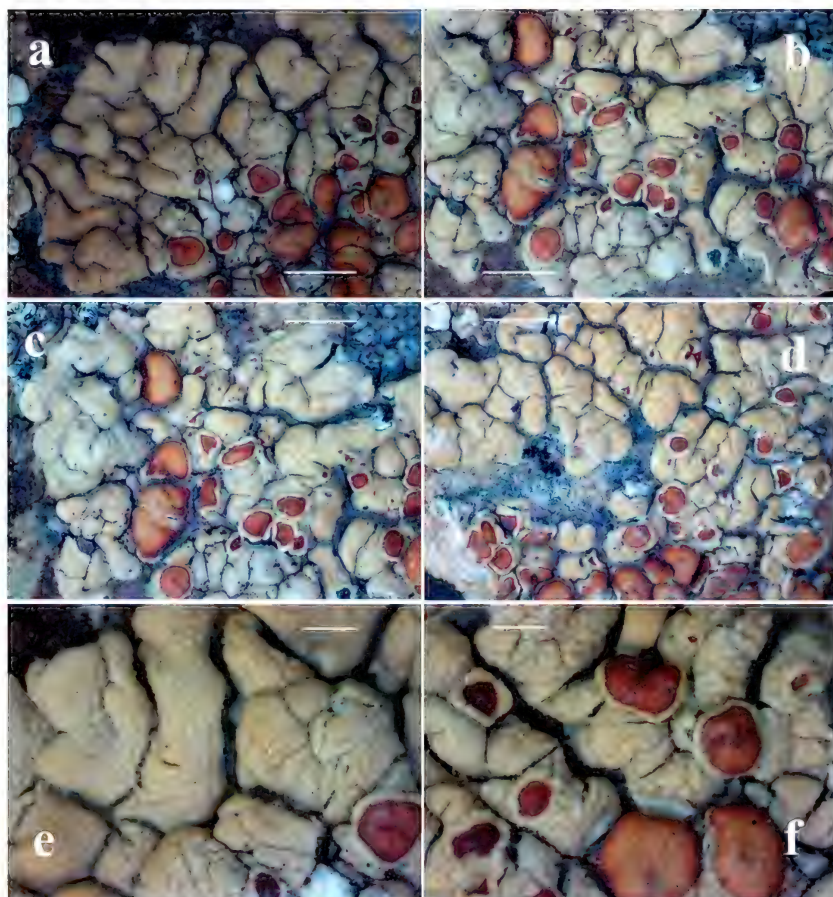


PLATE. 4. *Sedelnikovaea baicalensis*. a–d. General habit; e. Enlarged portion of thallus; f. Apothecia. Scale bars: a–d = 3 mm; e, f = 1 mm.

and *Lobothallia* (Clauzade & Cl. Roux) Hafellner (*Megasporaceae*). Our combined ITS + 12S mt SSU phylogenetic analysis suggest that *Sedelnikovaea* is most closely related to genera representing several different families: *Boreoplaca* (*Lecanoraceae*), *Steinia* (*Lecideaceae* or *Aphanopsidaceae*), *Pycnora* (*Lecideaceae*), and *Lobothallia* (*Megasporaceae*). Unfortunately GenBank does not contain both nuclear and mitochondrial sequences for the same species in each of the four genera so that we can only infer that the new genus is unique. Nonetheless, our data confirm that *Sedelnikovaea* is only distantly related to *Protoparmeliopsis*.

TYPE OF ASCUS — The *Sedelnikovaea*-type ascus shares some characters with the *Lecanora*-, *Candelariella*-, and *Biatora*-type asci. The *Sedelnikovaea*-type shares the strongly thickened apex with a K/I+ pale blue apical dome and a broad K/I– apical cushion found in the *Lecanora* and similar *Candelariella* types (Edwards et al. 2009). Furthermore, the apical cushion is surrounded by a narrow, deeply K/I+ blue zone as seen in the *Biatora*-type (Printzen & Coppins 2009) (Pl. 3). Unlike the *Candelariella*-type, *Sedelnikovaea* asci have only a narrow deeply K/I+ blue zone around the basal part of the apical cushion, unlike the uniformly deep blue apical cushion of *Candelariella*. The *Biatora*-type ascus is distinguished by a narrowly conical K/I– apical cushion that contrasts with the broad cushion found in *Sedelnikovaea*.

As shown above, *Sedelnikovaea baicalensis* shows the highest affinity with *Steinia* and *Pycnora* according to nuclear DNA and with *Boreoplaca* and *Lobothallia* according to mitochondrial DNA. *Pycnora* and *Boreoplaca* are characterized by a *Lecanora*-type ascus (Coppins 2009), while *Megaspora* and *Lobothallia* are characterized by the *Biatora*-ascus type (James & Fletcher 2009). Among the genera mentioned, *Steinia* alone possesses a thin-walled *Aphanopsis*-type ascus (Fletcher et al. 2009). According to Wolseley & Purvis (2009) the *Aphanopsis* ascus is similar to the *Trapelia*-type, but this possibly requires confirmation with fresh material. *Aphanopsis* and *Steinia* represent a separate family, *Aphanopsidaceae*. Finally, we should note that correlation between ascus type and DNA-phylogeny is generally poor in the *Lecanorales* (Ekman et al. 2008).

Our data on Russian, Uzbek, and Chinese material of *Sedelnikovaea baicalensis* completely agrees with the description published in the ‘Handbook of the Lichens of the USSR’ (Kopachevskaya 1971, as *Placolecanora baicalensis*), with the exception that the asci we measured were much wider: (13–)15–18 (–20) μm vs. 8.5–10.2 μm according to Kopachevskaya (1971).

Sedelnikovaea baicalensis usually grows on open, well-illuminated rock surfaces where it is often associated with *Dimelaena oreina*, *Lecanora frustulosa*, *Pleopsidium chlorophanum*, *Aspicilia transbaicalica*, *Aspicilia cinerea*, *Candelariella vitellina*, and *Rhizoplaca chrysoleuca*.

Additional molecular analyses of *Protoparmeliopsis* and *Sedelnikovaea* will most likely reveal further species that belong in *Sedelnikovaea*.

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